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ABSTRACT

During the past decade, satellite technology has grown increasingly more sophisticated. Satellites are being used in public interest activities, especially through the Public Service Satellite Consortium. But what about the field of education? How can education, especially vocational education, make use of satellite communications technology? In order to make this technology work for it, vocational education will have to make some changes. It must become more flexible, more interdisciplinary; it must provide more equal opportunities; and it needs more "hands on" experiences, simulation, and innovative teaching methods. In order to make use of satellite technology, educational personnel will have to consolidate their efforts. A satellite network could be used by several educational services, with perhaps a satellite terminal located in vocational education departments in each of the 50 state capitals. As satellite telecommunications costs continue to decrease, satellite use will become more common. Vocational education must be prepared to make use of this innovative new resource. (A list of planned and present satellites is contained in this report.) (KC)

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DELIVERY OF INSTRUCTIONAL MATERIALS USING A COMMUNICATIONS SATELLITE

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ABSTRACT

The state of the art in satellite technology is dynamic. Changes are occuring on a daily basis. New systems are emerging with the capacity to keep pace with increasing demands, although questions of supply and saturation continue to be raised. Telecommunications in the public service has definitely been evident in the last decade, and from all indications, will increase dramatically in the next decade. What about the field of education? Facilitating innovation in education, because of its fragmentation, is a complex task. How can educational institutions adopt and implement telecommunications technology? How will the schools adapt their planning, budgeting, and operating practices to meet the requirements of alternative distribution systems? This report addresses the issues of effective utilization of advanced telecommunications technology in the schools.

INTRODUCTION

The last decade witnessed a driving move from experimental communications satellite usage toward a slow but steady growth in technology transfer to current domestic systems. The 1980's hold much promise of increased technological advancements, making satellite communications technology available to the masses. On the wish list we find that public service applications are mentioned often, but relative to our assigned topic, what are the realistic prospects for the field of education?

Education and communications satellite technology are not strangers. In fact, they've been courting for over a decade. The Pacific Basin area has made extensive use of the ATS-1 experimental communications satellite, launched in 1966, for educational programs such as PEACESAT and USPNET. Alaska has also utilized ATS-1 since 1971 for distribution of health and education programs and services. It is worth noting that from a very modest beginnning on ATS-1 and ATS-3, Alaska has made the transition to commercial satellite services and will acquire its own dedicated satellite in late 1982.

The ATS-6 experiments in 1974 and 1975 marked the beginning of a new era in educational technology, demonstrating the provision of improved educational and health services to such geographically remote areas as Alaska, Appalachia, and the Rocky Mountain region, heretofore isolated from desperately needed services. The most recent experimental satellite was the CTS, a joint project of the U.S. and Canada, which operated from 1976 to 1979. Of the 20 approved long-term experiments and 146 one-time demonstrations using CTS, six experiments and 64 demonstrations were educationally-oriented. CTS was a unique satellite in that it operated at higher frequencies and with much greater power allowing the earth stations to be smaller, more portable, and relatively less costly.

Yet, when the experiemental satellites were no more, most of the public service groups terminated their satellite communications usage. Why, after such a long courtship, can't education and communications satellite technology enter into marriage? Is it a question of resources, incompatibility, or simply immaturity? To better understand this reluctant couple, we need to examine the condition of education as affected by telecommunications.

COMMUNICATIONS SATELLITE BACKGROUND

There are thirteen U.S. domestic communications satellites currently operating, with the FCC authorizing the launch and construction of at least 25 more. The 144 transponders, or channels, looking at the U.S. in 1981 will increase to 300 in 1982 and 600 by the end of 1985. This seems like quite a few until it is realized that presently it takes one full transponder to accommodate one full motion video signal. Compression techniques, which are discussed later, will maximize transponder capacity. (A complete list of current and projected U.S. satellites is appended.)

How do they work? Communications satellites are really just microwave towers in the sky, reflecting transmitted signals to ground receiving stations.

The satellites are positioned 22,300 miles above the Earth over the equator. At that altitude they become "geostationary"; that is, they orbit the Earth at the same speed the Earth spins, causing the satellites to appear to remain in one place. Thus, a fixed earth antenna can focus on them, using them continuously.

One advantage to using communications satellites is the large area the signal can cover. The antenna coverage, or "footprint", of a satellite covers about one-third of the Earth's surface--enough to encompass the continental U.S., Canada, Alaska, and Hawaii, with the exception of the extreme northern and southern latitudes.

Such coverage enables satellites to be distance-insensitive. Once a signal is up to the satellite, it costs no more to transmit the signal to a point 2000 miles from the point of origin than it does to transmit the signal to a point two miles from the point of origin. Land communications, on the other hand, are very distance-sensitive. A look at long distance phone rates confirms this.

Satellite communications are particularly well suited for simultaneous communication among a large number of locations. It takes only one-fourth of a second to transmit a signal up to a satellite and back to Earth. A special antenna, many of them only ten feet in diameter and shaped like a round dish, receives these signals. There are over 5000 of these satellite receiving "dishes" nationwide in use by cable systems, public television stations,

hotels, and hospitals. The most prevalent ad hoc network nodes available today include:

Type of Facility	Number of Nodes
Public Television Stations	160*
Holiday Inns	286
Hospitals and Medical Facilities	300
Transportable Earth Stations (receive only)	220
Various "Independent" Facilities (hotels, libraries, etc.)	hundreds

*Eight more stations will be going on line soon, and an additional 127 stations can be reached through state microwave relay systems.

Interest in using satellite communications for occasional programming is rapidly growing. Conference sessions, continuing education, seminars, and instructional materials are a few of the types of programs using satellite delivery and distribution. Through the use of satellites, travel time and money can be saved, more participants can be reached and served, and materials and resources can be shared.

And what of the future? Technological advances, such as those listed below, will make satellite communications even more accessible.

Direct Broadcast Satellites (DBS)

DBS technology can bring about low cost, rooftop satellite receiving stations (less than $1000 per unit) and a revolution in commercial television. Currently, 14 groups have submitted proposals to the FCC, of which nine are considered serious. Once approved by the FCC, DBS will concentrate on service as a mass communications medium affordable to individual residences.

Video Compression

As previously mentioned, a full transponder is needed per video signal. By 1983, however, bandwidth compression techniques should permit transponders to accommodate more than one video signal, making satellite transmission even more economical. Since satellite time will continue to rise in demand, such techniques will be instrumental in future transponder accessibility. The predictions are that bandwidth compression will permit a video signal to be transmitted using only ten percent of a transponder.

Ku-Band Satellite Networks

Except for the U.S. SBS and Canadian ANIK satellites, current domestic satellites operate in the 6/4 GHz frequency range (C-Band). Most of the present earth station networks are compatible with these frequencies.

The newer generation of satellites, however, is evolving to 14/12 GHz (Ku-Band). This phenomenon has sparked earth station manufacturers into creating a new line of Ku-band earth stations as well as a hybrid, commonly called a Torus antenna, which is able to accommodate both C-Band and Ku-Band frequencies.

Use of Ku-Band frequencies and subsequent Ku-Band networks will open up a new range of satellite communications opportunities, providing more service alternatives in the wake of a crowded C-Band.

THE NATURE OF VOCATIONAL EDUCATION

In keeping with the theme of the conference, let us now examine public vocational and industrial education and training. The focus of this paper, however, will be on vocational education because, interpreted in its broadest sense, it has tremendous implications for education in general, and because vocational education is most amenable to advanced telecommunications.

The 1970's and early 1980's are finding vocational education becoming even more an integral part of American education, often segmented into special categories: technical education; industrial education; career education; occupational education; and professional education. No longer is vocational education limited to non-college prep students or available only in specialized institutions.

In their 1980 report, the National Center for Education Statistics (NCES) found almost 28,000 institutions offered some type of vocational education from graduate schools to correctional facilities. Two-thirds of those institutions were at the secondary level where, until 1981, federal funds were more readily available. Of the nearly 20 million vocational students enrolled in these institutions, 65 percent were secondary students and 35 percent were postsecondary students.

Where can vocational education programs and students be found? Let us share some interesting observations with implications for telecommunications. While only 27 percent of the population lives in areas with under 100,000 residents, 60 percent of the secondary schools offering at least five vocational education programs can be found there. Post secondary vocational programs, however, are largely located in multi-town service areas.

The NCES statistics profile the vocational education student as secondary, rural, with a good chance of being a minority, and interested in consumer/homemaking or office occupations programs.

While the above profile may seem to perpetuate the traditional image, changes in occupational opportunities and the expansion of required job skills are sending large numbers in search of more education and training. More employers are offering benefits or on-site training to ensure first-rate employees. The implications and applications for telecommunications follow.

EDUCATIONAL APPLICATIONS

How can we reconcile the premarital differences between vocational education and telecommunications technology? Reconciliation can only come about through a mutual understanding of needs, problems, and aspirations.

Vocational Education Must Become More Flexible

As financial pressures increase, more students of all ages find it necessary to work, and often it's a full time job. They must rely on finding curricula able to fit into a full schedule. A one day a week seminar might be more accessible than a one semester, three day a week course. Often the professional student is more in need of a review or an update, and not an entire in-depth course of study. Not only is flexibility of scheduling important, but also flexibility of location. A two hour drive twice a week to a night class is not as attractive as a program available at home.

For illustration purposes, consider this scenario. A satellite-facilitated project providing a high degree of flexibility is established. The local library becomes the vocational education facility, offering students the opportunity to enroll in a telecourse. The coursewear is available for use at the library whenever the student is able to come. These videotapes are supplemented with several short live interactive satellite video-teleconferences linking these students nationwide with course specialists who can provide instant feedback simultaneously to many students, without the need to travel to individual sites.

Vocational Education Must Become More Interdisciplinary

Many students find as they enter the labor force they need better preparation in areas besides their own major subject field. Employers are requiring more intrapersonal and communications skills. Technological advancements are imposing new job entry qualifications, particularly in the area of automation. In an age of increasing specialization, the average employee must still be a generalist to interface with his/her co-workers and clients.

More and more is being written about the need for shared resources and institutional cooperation. Satellite communications can provide the link needed to bring student and resource together. Currently, the Association for Higher Education in North Texas (AHE) operates a microwave network among ten academic institutions in the northern Texas area. In addition to these facilities, Texas Instruments and other business and industrial firms also take advantage of this network for training of their employees. Recently, AHE investigated the installation of a satellite terminal to expand the network nationwide. Such a move would open a variety of opportunities for sharing and accessing instructional materials and human resources.

Let's take a closer look at sharing human resources. While it may be financially impractical for a smaller institution to secure the lecture services of a Carl Sagan, for example, several institutions joining together to produce an interactive satellite-transmitted teleconference to several sites provides a cost-effective alternative.

In addition to educational video programs, the development of teletext/videotex provides potential for interactive home reference services. Ted Turner has been testing the feasibility and marketability of encoding such a service in the vertical blanking interval of WTBS, his Atlanta-based superstation, which is distributed nationwide via satellite.

Home media centers will inevitably evolve as the cost of technology decreases and the availability of programming increases. By the year 2000, many homes will be wired for two-way, interactive cable that will deliver not only entertainment and educational programming but such services as home banking and shopping and fire alarm protection. Homes will be interconnected with libraries and other data banks, and the telephone coupled with a display screen will serve as the computer.

Vocational Education Must Overcome Its Inequality of Opportunity

Extending the classroom and the learning resource center into the home is a logical progression of the extension center and mini-campus, and what better way than to use a distance- and terrain-insensitive communications satellite able to penetrate isolated areas most in need. With many vocational education facilities with limited programs located in rural areas, this becomes even more important.

The American Dietetic Association (ADA) is one of a select group transferring its experimental satellite efforts into current routine practice. As certification agent for a profession in need of constant continuing education, ADA has incorporated satellite technology in the delivery of live, interactive tele-seminars. Originating from wherever the program talent is located, these half day to day long seminars are reaching 3,000 dietitians nationwide. Registration and participation in these courses earns the dietitian credit hours toward certification requirements. Such professional education is saving dietitians and their employers time and money otherwise spent traveling to an accredited institution, one which is not always easily accessible. And, with the growth of the Association of Hospital Television Networks, many of these hospital dietitians are able to view the program in the comfort of their own building.

This phenomenon is not limited to professional education. Postsecondary students are also gaining more exposure to satellite-delivered instruction. Recently, three U.S. dental schools teamed up for an instructional teleconference. Mini-segments were presented by each of the three schools from their cities--Indianapolis, IN; Jackson, MS; and Baltimore, MD--to dental students gathered at public television stations all over the U.S.

So far, relatively little has been done directly using satellites for secondary vocational education. Yet, secondary schools are becoming more involved with local cable systems, and satellite technology becomes an easy interface. One high school in northern Illinois has a student-built satellite terminal which has been used to receive programming available from the Canadian ANIK satellite. This experience leads us to ask, "If vocational students can build homes, why not satellite receiving stations?"

Vocational Education Needs More "Hands On", Simulation, and Innovative Teaching Methods

Vocational education is often called practical, as opposed to theoretical, with some schools ensuring that at least 40 percent of each school day is spent in job-like situations. Work experience, apprenticeships, and on the job training are highly valued, and rightly so. No amount of academic coursework will ever take the place of student teaching for learning the fundamentals of teacher-student relationships. Occupations requiring a great amount of decision-making and physical aptitude are now incorporating more and more appropriate learning experiences in their training.

The increased use of simulation serves as an illustration. If you wanted to learn to fly a plane, you used to have to rely on receiving the flight lessons in an actual plane. Today many pilot trainees can use airplane simulators for much of the training and more practice. Meteorologists used to have to travel to the storms to study them. Now, storms can be simulated in their laboratories. Simulation is providing a very cost-effective method of study from computer simulation, to mechanical simulation, to environmental simulation. Look at the popularity of today's video games--each one a simulation in its own right. And, such simulation often accommodates the needs of special populations such as handicapped students.

How can satellite communications possibly help here? Inject satellite services and you add a new dimension to simulation. For example, an airport disaster was recently simulated, with doctors at VA hospitals diagnosing the victims via satellite. The American College of Radiology has successfully tested the transmission of x-rays via satellite. The University of Colorado Medical School in Denver, a CTS experimenter, demonstrated the feasibility of sharing expensive medical equipment, such as the CAT Scanner, via satellite link. CTS was also used by law students participating in mock trials. Finally, selected pre-medical students from Alaska, Idaho, and Montana, who were seeking admission to the University of Washington School of Medicine in Seattle, were interviewed via experimental satellite.

A NEED FOR AGGREGATION

During its seven years of existence, the Public Service Satellite Consortium has taken pride in helping public service groups apply advanced telecommunications, specifically satellite communications, to their communications needs. Our National Satellite Network (NSN) arm has provided satellite teleconferencing assistance resulting in the coordination of over 200 events, many repeat users. As a membership organization, with over 100 member groups, PSSC can attest to the need for aggregation, cooperation, and shared resources in the application of satellite technology. Not everyone has the means to build a dedicated satellite network, or even to sponsor a teleconference alone, but aggregated with others, such dreams can become a reality.

A PROPOSED NETWORK

In the aftermath of economic constraints, state education departments are finding general budgets being decreased while educational sub-segment support increases, both in public visibility and in need. We now often find separate offices not only for vocational education, but also for bilingual education, special education (gifted, physically and mentally handicapped), migrant education, and other specialized fields. State libraries are often within the education department as well. Since the housing of these offices together is a form of physical aggregation, one potentially viable satellite network could revolve around the linking of all state departments of education.

A satellite terminal would be located on or near the facilities of each department in each of the 50 state capitals. While video programming would be of primary importance, the capability of interfacing the satellite technology with any existing or planned computer technology for high speed data transmission is also a potential use of the network.

Such a dedicated satellite network could service a variety of area users, including departmental offices, staff and constituents; governmental agencies; related professional associations; and educational and library facilities. A shared user fee would reflect the cost-effectiveness of such planned aggregation. The users need not be limited to state groups; many Federal government groups need to reach their state counterparts. PSSC recently coordinated a satellite video-teleconference for the Corporation for Public Broadcasting (CPB) and the Vocational Education Data Service (VEDS) of the National Center for Education Statistics. Participants gathered in state capital cities to discuss statistical reporting on vocational education programs via interactive video-teleconference. Such a program enabled the presentation of information once, simultaneously to all in need, with the added benefit of instant feedback.

THE NEAR FUTURE

As telecommunications costs continue to drop, while satellites become more powerful and earth stations become smaller and less expensive, there is no doubt that satellite technology will be as common and personal as telephones and television sets. Direct broadcast satellites will beam programming to tiny satellite antennas on our roofs. We will use our television sets to learn, to shop, to bank, and to express our opinions on every subject imaginable.

Delivery of instructional materials using a communications satellite will also become more common as it becomes more affordable. But as the information explosion continues to outdate prepared information on a daily basis, we are going to rely more on human resources. The sharing of experts and specialists via satellite will become even more important. Special groups, such as the Institute for Career and Vocational Training, are already looking at the feasibility of linking job banks, career counseling and guidance information, and resources via satellite, particularly since their target audience is American Indians, many of whom

reside in isolated reservations.

In an era of limited resources, one bright light appears that merits mention. The Annenberg School of Communications has granted ten million dollars per year for 15 years to the Corporation for Public Broadcasting to establish and administer a project to provide American institutions of higher education with a significant new resource of educational programming and to explore and discover new ways to advance American higher education through telecommunications. The goals of the Annenberg project are: (1) to create one or more significant collections of new, innovative, high-quality college-level materials (the term "college-level materials" is understood to include telecourses, radio/audio series, television series, print components and computer materials and might consist of sequences of series/courses, a single series/course, or modules to be used within existing courses, or any combination of the above.); and (2) to demonstrate the use of communications systems for addressing unique higher education problems.

Edgar H. Schein in his report, "Professional Education: Some New Directions," describes the future professional school:

> The new professional school would integrate the basic sciences, applied sciences, and professional skills. A variety of professional degrees would be offered, requiring different lengths of time to complete. There would be a small permanent faculty and a large part-time faculty to permit the offering of a wide range of classes. The adjunct faculty would function like consultants teaching at several different schools and possibly maintaining some private practice as well. Physically, the new professional school would be organized around a "learning resource center" that should include as many laboratories and "application-oriented subcenters" as possible, much like a teaching hospital that is tied closely to various community activities.

We submit one addition to Mr. Schein's description: a satellite terminal near the learning resource center.

ADVICE TO THE LOVE LORN

People in education must learn to speak the language of technology. Technologists, in turn, need a better understanding of public service needs and requirements. Understanding is a prerequisite to marriage. The more you know, the less you distort.

Traditional practices in a technological environment can create conflict. The burden is on the educator. The decision making environment must change to accommodate new technologies. Education must reach out for the non-traditional student and program. We can't apply tomorrow's technology to yesterday's problem.

Historically, innovation in education has been stimulated by some form of subsidy, call it a dowry for illustration purposes. Today, with the economic realities in the Federal government, the prospects for a dowry are diminishing. There is no dowry, and to delay the ceremony in hopes of attracting a rich uncle is futile. If education is to systematically enter the world of modern telecommunications, it must take the first step. With any new venture there is risk and there is uncertainty, but the potential return merits action. The field of education as we know it cannot afford to wait. The technology is waiting at the altar and is getting impatient.

SATELLITES: PLANNED AND PRESENT

WESTAR: Owned and operated by Western Union. Twelve transponders each.

- WESTAR I--(launched 1974)--Used for primary PBS and NPR programming, offers some occasional traffic.
- WESTAR II--(launched 1974)--Primarily message traffic.
- WESTAR III--(launched 1979)--Message, occasional, independent, and cable networks.
- WESTAR IV--(launched 1982)--24 transponders.
- WESTAR V--(to be launched 1982)--24 transponders.
- Advanced WESTAR--(to be launched 1983)--18 transponders.

SATCOM: Owned and operated by RCA Americom. Twenty-four transponders each.

- SATCOM I--(launched 1975)--Was all cable programming traffic (Cablenet I). Currently being phased into retirement.
- SATCOM II--(launched 1976)--Primarily Alaskan programming traffic.
- SATCOM III--(launched 1980)--Lost during launch.
- SATCOM IIIr--(launched 1981)--Replacement for SATCOM III; new Cablenet I.
- SATCOM IV--(launched 1982)--Cablenet II.
- SATCOM V--(to be launched 1982)--Will be dedicated to Alaskan programming. (ALASCOM I)

COMSTAR: Owned and operated by COMSAT General; leased to AT&T and GTE. 24 transponders each.

- COMSTAR D1--(launched 1976)--Primarily telephone and data service. Eleven transponders were leased to cable programmers due to loss of SATCOM III.
- COMSTAR D2--(launched 1976)--Same as D1.
- COMSTAR D3--(launched 1978)--Primarily telephone and data service.
- COMSTAR D4--(launched 1981)--Primarily telephone and data service.

AT&T 1--(to be launched 1983).

G-SAT 1 and 2--(to be launched 1984).

SBS: Owned and operated by Satellite Business Systems.
10 transponders each--Ku-Band.

SBS 1--(launched 1981)--Primarily data service.

SBS 2--(launched 1981)--Primarily data service.

SBS 3--(to be launched 1982+).

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